Does disorder hurt in photonic crystals?

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Disorder can play an important role in photonic crystals. Disorder effects range from anisotropic diffusion, and non-Lambertian light sources to light localization. Unavoidable variations in size and position of the building blocks of photonic crystals cause light scattering and extinction of coherent beams. We present a new model for both 2 and 3-dimensional photonic crystals that relates the extinction length to the magnitude of the variations. The predicted lengths agree well with our new experiments on high-quality opals and inverse opals, and with literature data analyzed by us. As a result, control over photons is limited to distances up to 50 lattice parameters in state-of-the-art structures, thereby seeming to impede at present large-scale applications such as integrated circuits. Conversely, scattering in photonic crystals may lead to novel physics such as Anderson localization and non-classical diffusion.

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